Jet Propulsion Laboratory
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GITM Results for the 17 March 2013 Storm: Challenges in estimating IT energy budget

IEMIT-MMV joint session for ionospheric conductance challenge

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Verkhoglyadova, O. P., X. Meng, A. J. Manucci, M. G. Mlynczak, L. A. Hunt, G. Lu (2017), Ionosphere-thermosphere energy budgets for the ICME storms of March 2013 and 2015 estimated with GITM and observational proxies, Space Weather, 15, doi:10.1002/2017SW001650

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Challenges in estimating I-T Energy Budget

$$Q_{JH} = \sigma_P [\boldsymbol{E} + u_n \times \boldsymbol{B}]^2$$

Major challenge: Estimating/Measuring four parameters at the same time

from an I-T modeling perspective

1. Including neutral dynamics:

- Thayer and Vickrey, 1992 showed the importance of **neutral wind dynamo** in M-I coupling.
- Lu et al. [1995], showed neutral winds had a **%28 negative** effect on Q_{JH}.
- Deng and Ridley [2007], showed **%20 enhancement** in energy deposition through Q_{JH} with GITM where neutral winds are accounted for.
- Zhu and Ridley (2015) implemented **ion-neutral collisional heating** to GITM further improving Q_{JH} modeling.

2. Consistency between electric fields and particle precipitation:

- The empirical models for particle precipitation and convection patterns are developed separately from **different data** sets.
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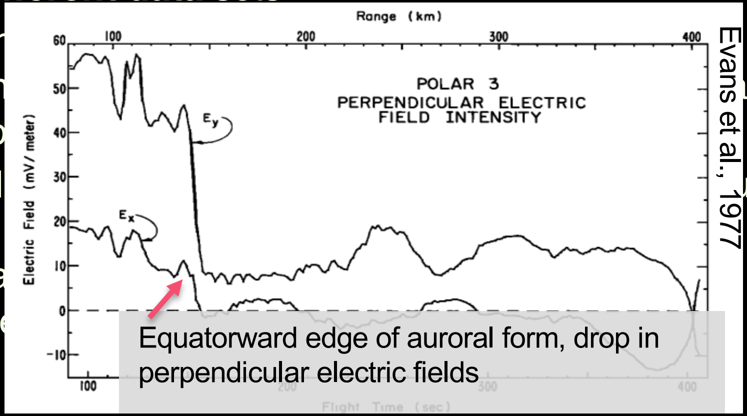
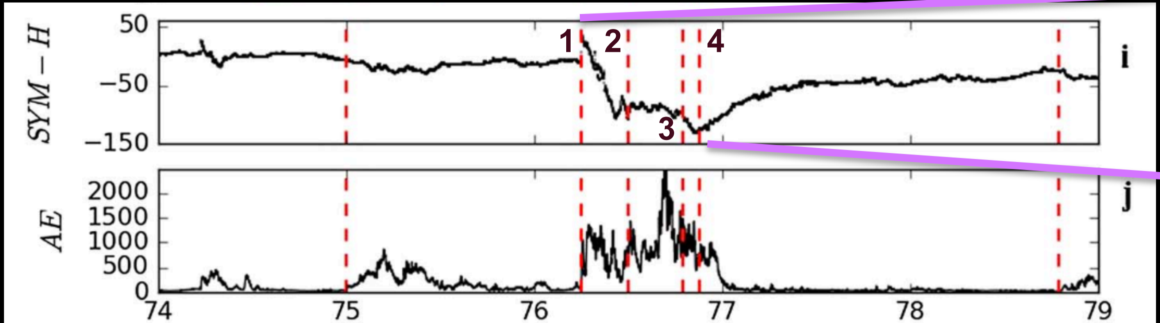
- Cl… …ure to… ba… me…



Equatorward edge of auroral form, drop in perpendicular electric fields

Simulation Setup

- Modeling of the storm through Global Ionosphere Thermosphere Model (GITM)[1]
- Drivers for Ionospheric Electrodynamics (1-min):
  1. Weimer 2005[2] model for high-latitude ionospheric potentials
  2. OVATION Prime[3] for auroral particle precipitation
- Grid resolution: $3.\overline{3}°$ in longitude, 1° latitude, 1/3 local scale height in vertical direction, ~1s temporal resolution



Verkhoglyadova et al., 2017

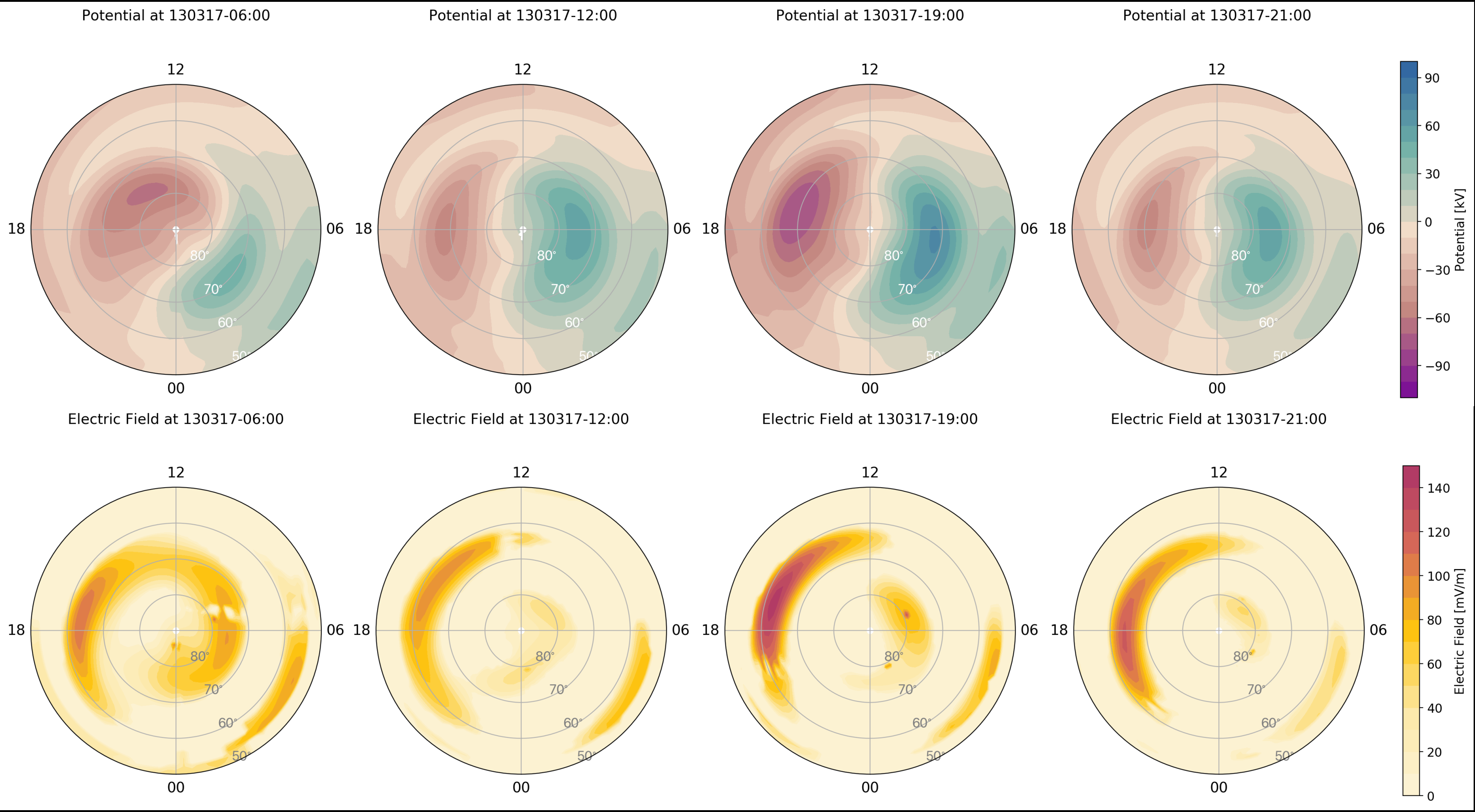
1. 0600 UT: Storm onset, SI+
2. 1200 UT: Storm main phase-I
3. 1900 UT: Storm main phase-II
4. 2100 UT: Storm recovery

1 Ridley et al., 2006
2 Weimer, 2005
3 Newell et al., 2009

Potential Patterns vs Electric Field Profiles

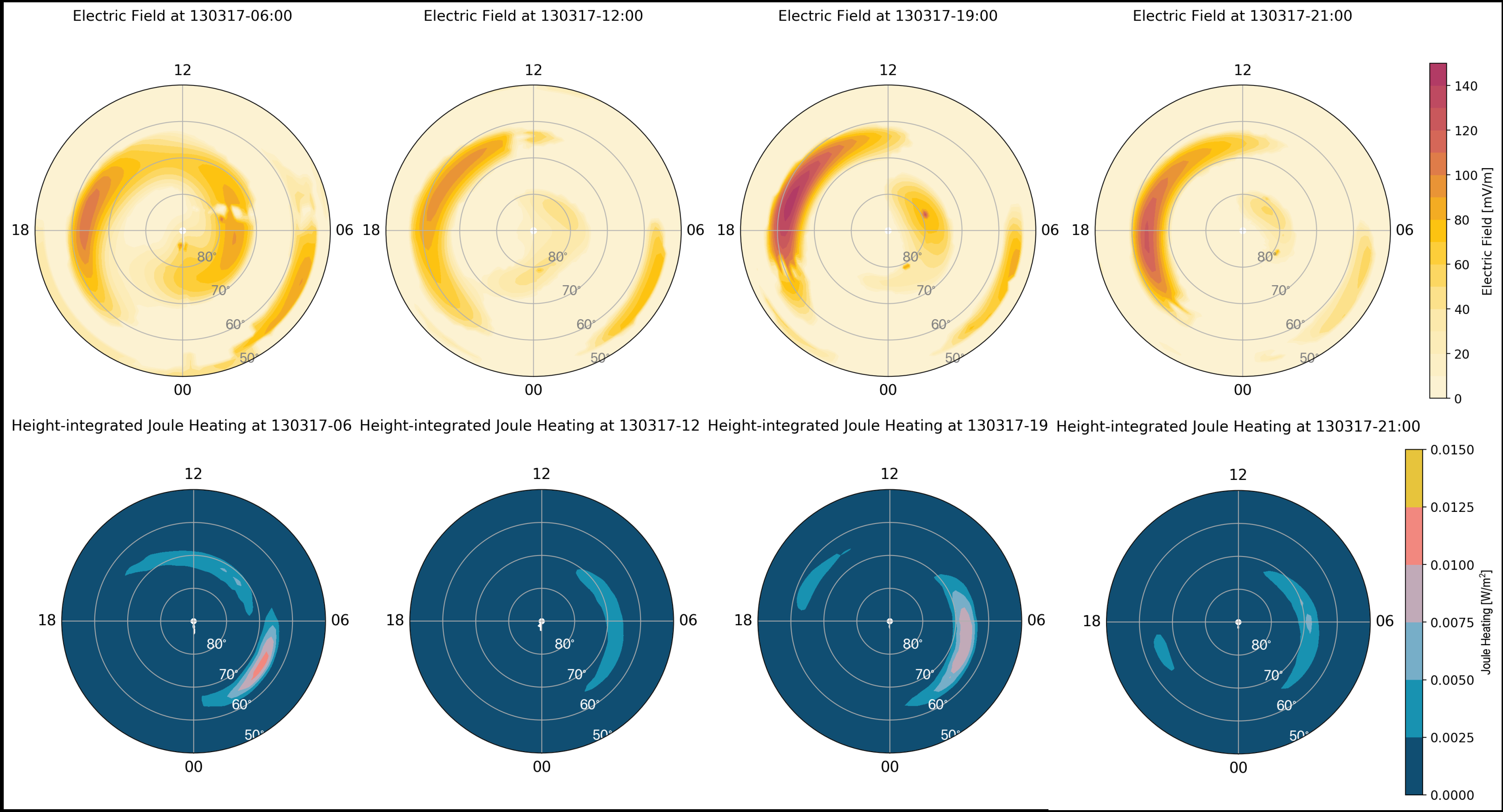
$$\boldsymbol{E} = -\nabla\Phi$$

- Electric fields in the dusk sector are stronger.
- High-latitude dawn electric fields are stronger in 1st and 3rd snapshots.



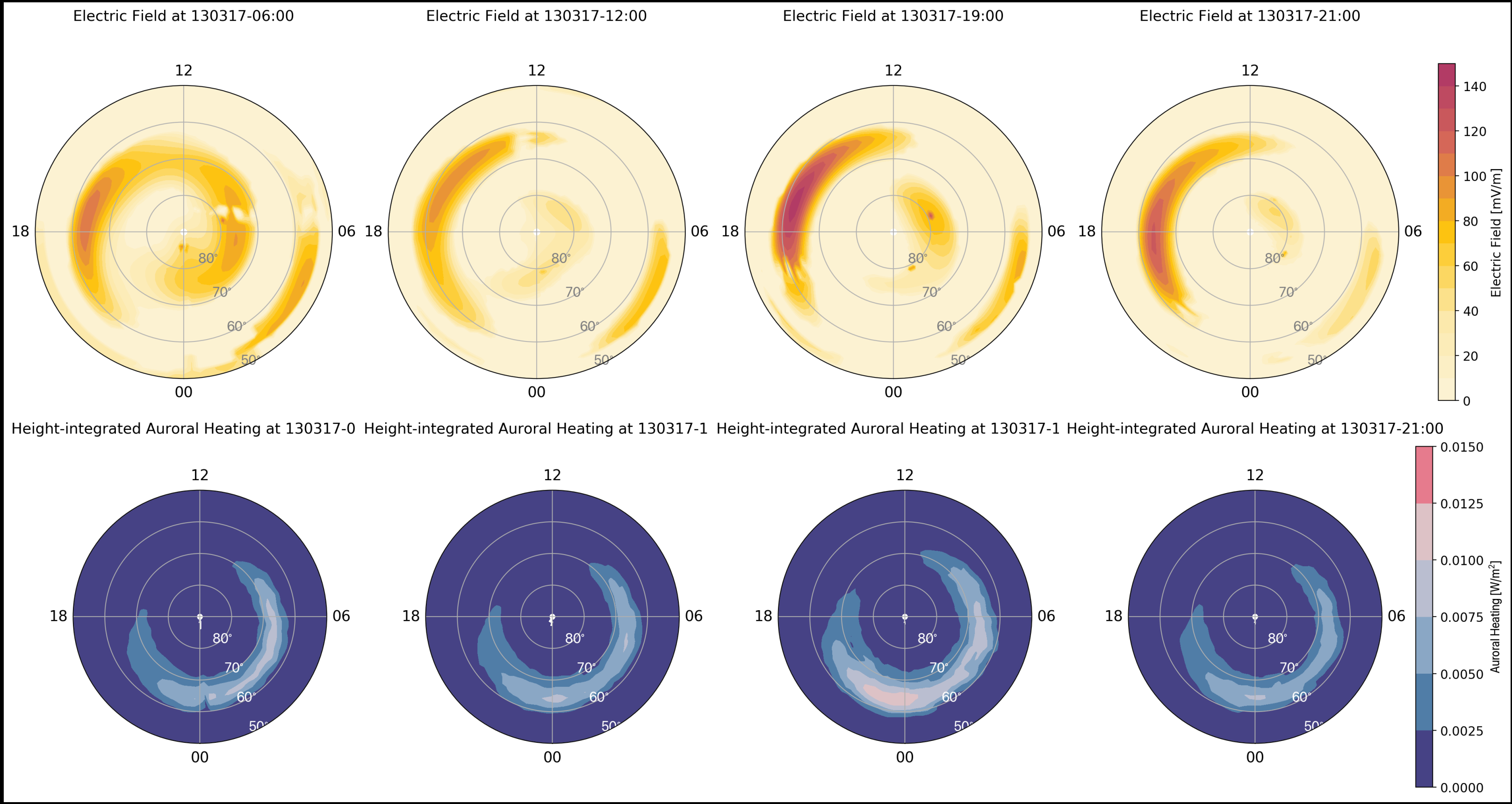
Electric Field vs Height-Integrated Joule Heating Profiles

Electric field magnitude and height-integrated Joule heating profiles do not show a strong correlation.



Electric Field vs Height-Integrated Auroral Heating Profiles

The nightside boundary of the dusk electric fields weakens as the auroral oval expands.



Conclusions and Future work

Conclusions:

- Consideration of I-T dynamics changes the location and magnitude of Joule Heating.
- A self-consistent treatment of particle precipitation and electrodynamics is important for a complete understanding of M-I-T coupling

Future work:

- We are developing a framework that can utilize **high-latitude local (meso-scale) 2D electric field measurements** as input to run a global I-T model.
- We aim to include such a self-consistent treatment of drivers in our modeling approach to understand I-T energy budget better.

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